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N89-22992

CHARACTERIZATION TESTING OF A 40 Ahr BIPOLAR NICKEL HYDROGEN BATTERY

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In a continuing effort to develop NiH_2 bipolar technology to a point where it can be used efficiently in space flight, Lewis Research Center (LeRC) has begun testing a second 40 Ahr, 10-cell bipolar battery. This battery, put on test in March, 1988, has undergone extensive characterization testing to determine the effects of such operating parameters as charge and discharge rates, temperature, and pressure.

The fundamental design of this actively cooled bipolar battery is the same as the first battery, also tested at LeRC. Most of the individual components, however, are from different manufacturers. Different testing procedures as well as certain unique battery characteristics make it difficult to directly compare the two sets of results. Some comparisons, however, can and will be made.

In general, the performance of this battery throughout characterization produced expected results. Varying the charge rate between C/4, C/2, and C had little effect on efficiencies while varying the discharge rate between C/4, C/2, C, and 2C had great effects on efficiencies, with C/4 producing the best results and 2C the worst. Temperature variations produced more puzzling results. Temperatures of 0°C, 10°C, 20°C, and 30°C were all used but not one of them showed a consistent efficiency advantage over the other three. End of charge voltages, however, did change -- decreasing as temperatures increased. Mid-point discharge voltages increased as temperatures increased, but only at the C and 2C rates. Initial tests also indicate a slight efficiency increase with an increase in vessel pressure from 200 to 400 psi. End of charge voltage appears to be unaffected by the increased pressure, but mid-point discharge voltages are slightly higher at the C/4 and C/2 discharge rates. An even greater difference is seen at the C and 2C rates.

The main differences seen between the first and second batteries occurred during the high-rate discharge portion of the test matrix. For the second battery, end-of-discharge voltage limits were reached within 15 seconds on the 10C constant current discharge rate and efficiencies of less than 30% were attained at the 5C constant current rate. Only during one-second-on, four-seconds-off 5C pulse current cycle were reasonable results produced. The first battery also had poor high-rate discharge results, although better than those of the second battery. Minor changes were made to the battery frame design used for the first battery in an attempt to allow better gas access to the reaction sites for the second build and hopefully improve performance. The changes, however, did not improve the performance of the second battery and could have possibly contributed to the poorer performance that was observed. There are other component differences that could have contributed to the poorer performance of the second battery. The H_2 electrode in the second battery was constructed with a Goretex backing which could have limited the high-rate current flow. The gas screen in the second battery had a larger mesh which again could have limited the high-rate current flow. Small scale 2" x 2" batteries are being tested to evaluate the effects of the component variations.

LEO cycle life testing at 40% DOD and 10°C is scheduled to follow the characterization.